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Docket No.: 041-479-L

Date: November 2, 2000



Assistant Commissioner for Patents  
Washington, D.C. 20231

### NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of Inventor(s):

**LEV SMORODINSKY**

Note: A patent must be applied for in the name(s) of all of the actual inventor(s). 37 CFR 1.41

For:

### METHOD FOR SERVER METAFARM CONFIGURATION OPTIMIZATION

Enclosed are:

1. **The Papers Required for Filing Date Under 37 CFR 1.53(b):**

28 Pages of specification  
1 Pages of Abstract  
5 Pages of claims  
4 Sheets of drawings  
\_\_\_\_\_ formal  
X informal

In addition to the above papers, there is also attached:

\_\_\_\_\_ Pages of an amendment \_\_\_\_\_

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### CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being deposited with the United States Postal Service on this date, November 2, 2000, in an envelope as "Express Mail Post Office to Addressee" Mailing Label Number EL070486540US addressed to: Box Patent Application, Assistant Commissioner for Patents , Washington, D.C. 20231.

Patti S. Preddy  
(Type or print name of person mailing paper)

Patti S. Preddy  
(Signature of person mailing paper)

NOTE: Each paper or fee referred to as enclosed herein has the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 CFR 1.10(b).

**2. Declaration or oath**

Enclosed

original

executed by (check all applicable boxes)

inventor(s)

\_\_\_\_\_

legal representative of inventor(s) 37 CFR 1.42 or 1.43

\_\_\_\_\_

joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.

\_\_\_\_\_

This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 also attached. See item 7 below for fee.

\_\_\_\_\_ Not enclosed

NOTE: Where the filing is a completion in the U.S. of an international application under 35 U.S.C. 371(c)(4), the declaration must be filed.

\_\_\_\_\_ Application is made by a person authorized under 37 CFR 1.41(c) on behalf of all of the above-named inventor(s). The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently.

NOTE: It is important that all the correct inventor(s) are named for filing under CFR 1.41(c) and 1.53(b).

\_\_\_\_\_ Showing that the filing is authorized. (Not required unless called into question. 37 CFR 1.141(d)).

**3. Language**

English

\_\_\_\_\_ non-English

NOTE: An application including a signed oath or declaration may be filed in a language other than English. A verified English translation of the non-English language application and the processing fee of \$20.00 required by 37 CFR 1.17(K) is required to be filed with the application or within such time as may be set by the Office. 37 CFR 1.52(d).

NOTE: A non-English oath or declaration in the form provided or approved by the PTO need not be translated. 37CFR1.60(b).

\_\_\_\_\_ A verified English translation of the specification is attached.

**4. Assignment**

An assignment of the invention to UNISYS CORPORATION

**5. Certified Copy**

\_\_\_\_\_ A certified copy of application(s) from which priority is claimed.

NOTE: Must be referred to in oath or declaration. 37CFR1.55 and 1.63.

**6. Fee Calculation**

**CLAIMS AS FILED**

Number Filed	Number Extra	Rate	Basic Fee \$710.00
Total Claims -12- -20=	-0- X	\$ 18.00	-0-
Independent Claims -1- -3=	-0- X	\$ 80.00	-0-
Multiple dependent claim(s) if any -0-	-0- X	\$270.00	-0-

\_\_\_\_\_ Amendment canceling extra claims enclosed

\_\_\_\_\_ Amendment deleting multiple dependencies enclosed

\_\_\_\_\_ Fee for extra claims not being paid at this time

NOTE: If the fees for extra claims are not paid on filing, they must be paid or the claims canceled by amendment prior to the expiration of time period set for response by the Patent and Trademark Office in any notice of fee deficiency.

37 CFR 1.16(d)

Filing Fee Calculation \$ 710.00

**7. Small Entity Statement**

\_\_\_\_\_ verified statement that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is attached.

Filing Fee Calculation (50% of above) \$ \_\_\_\_\_

**8. Fee Payment Being Made At This Time**

\_\_\_\_\_ Not Enclosed

\_\_\_\_\_ No filing fee is to be paid at this time. This and the surcharge required by 37 CFR 1.6(e) can be paid subsequently.

NOTE: Where the filing is completion in the U.S. of an international application, the fee must be paid.

X Enclosed

X basic filing fee \$ 710.00

X recording assignment \$ 40.00

(40.00 37CFR 1.21(h)(j)

\_\_\_\_\_ petition fee for filing by other than all the inventors or person on behalf of the inventor where inventor refused to sign or cannot be reached. (\$130.00 37 CFR 1.47 and 1.17(h) \$ \_\_\_\_\_

_____	for processing an application with a specification in a non-English language (\$20.00; 37 CFR 1.53(d) and 1.17(k))	\$ _____
_____	processing and retention fee \$100.00; 37 CFR 1.21(l))	\$ _____

NOTE: 37 CFR 1.21(l) establishes a fee for processing and retaining any application which is abandoned for failing to complete the application pursuant to 37 CFR 1.53(d) and this, as well as the changes to 37 CFR 1.53 and 1.78 indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee or the processing and retention fee of §1.21(l) within one year from notification under § 53(d) must be paid.

Total fees enclosed	<u>\$750.00</u>
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#### 9. Method of Payment of Fees

check in the amount of \$ \_\_\_\_\_  
 charge Account No. 19-3790 in the amount of \$750.00. A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b)

#### 10. Authorization to Charge Additional Fees

NOTE: If no fees are to be paid on filing, the following items should **not** be completed.

WARNING: If these boxes are to be checked, then accurately count claims, especially multiple dependent claims, to avoid unexpected high charges.

The Commissioner is hereby authorized to charge the following additional fees which may be require to Account No. 19-3790.

- 37 CFR 1.16 (filing fees and presentation of extra claims)
- 37 CFR 1.17 (application processing fees)
- 37 CFR 1.18 (issue fee at or before Mailing of Notice of Allowance, pursuant to 37 CFR 1.31(b)).

NOTE: 37 CFR 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application ...prior to pay...issue fee."

#### 11. Instructions As To Overpayment

credit Account No. 19-3790  
 refund

Alfred W. Kozak  
 Signature of Attorney

Alfred W. Kozak  
 (Type or print name of attorney)

Unisys Corporation  
 10850 Via Frontera, MS 1000  
 San Diego, CA 92127

Reg. No. 24,265

Tel No. (858) 451-4615

Docket 041-479-L

**TITLE: METHOD FOR SERVER METAFARM CONFIGURATION  
OPTIMIZATION**

**FIELD OF THE INVENTION:**

This invention relates to data processing systems of the type which include a Server Metafarm that includes one or more Server Farms that execute application programs for multiple clients (users); and more particularly, this invention relates to methods for optimizing the "Server Metafarm size" by balancing a number of Server Farms and availability requirements in the above type of data processing systems.

CROSS-REFERENCES TO RELATED APPLICATIONS:

This application is related to co-pending applications, USSN 08/550,603 entitled "Estimator Program for Estimating the Availability of an Application Program That Runs in a Cluster of at Least Two Computers"; USSN 09/443,926, entitled "Method for Estimating the Availability of an Operating Server Farm", and USSN 09/474,706, entitled "Method for Server Farm Configuration Optimization" which applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION:

The co-pending application "Estimator Program for Estimating the Availability of an Application Program That Runs in a Cluster of at Least Two Computers" referenced above involves an estimator program to perform method steps for estimating the availability of an application program that runs on any "server" in a cluster of at least two servers. By "availability of an application program" is meant the probability that at any particular time instance, at least one of the servers in a cluster (farm) will actually be servicing requests from external workstations able to use the application program.

In one embodiment, the so-called estimator program begins by receiving input parameters which include (i) multiple downtime periods for each computer in the cluster (farm) that occur at respective frequencies due to various downtime sources, and (ii) an

application "failover" time period for switching the running of the application program from any one computer to another computer which is operable. From these input parameters, the described estimator program estimates 5 first and second annual stoppage times, then determines the availability of the application program on the cluster of computers which is derived from the sum of the first and second annual stoppage times.

Thus, as discussed, the estimator program of 10 the previously-described invention estimated a first annual stoppage time for the application program due solely to the concurrent stoppage of all of the computers, as a function of the ratio of a single computer virtual downtime period over the single computer virtual time between stops. Then subsequently, the 15 estimator program was used to estimate a second annual stoppage time for the application program, due solely to the switching for running the application program from one computer to another computer as a function of the single virtual stoppage rate and the application failover time period. From this, the estimator program determined 20 the availability of the application program on the cluster of computers by deriving the sum of the first and second annual stoppage times.

The estimator program method was based on the 25 assumption that "application availability" was to be determined from four factors which were:

- (i) single-server hardware reliability;
- (ii) maintenance, support, and service 30 strategies;

(iii) user application and environment;

(iv) failover or system reconnection mechanism and application recovery mechanism.

The prior estimation parameters which were  
5 described in the co-pending application USSN 08/550,603 did not take into consideration the total number of operating Server Farm clients and the normal single server workload of users involved with each single server. Further, this earlier application did not  
10 provide a recommendation or estimate regarding the number of servers required in the Server Farm (or cluster) which would meet the customers' performance and redundancy level requirements, nor did it establish an optimum farm configuration.

15 The method of the co-pending application USSN 09/443,926, entitled "Method for Estimating the Availability of an Operating Server Farm" extended the area of the original method application for Server Farms designed to serve user communities with a required  
20 particular number of customers . This method involving the Server Farm size and availability calculations is based on (1) the single server parameters such as (a) the meantime to failure (MTTF), (b) the meantime to repair (MTTR), and (c) the single server application performance  
25 benchmarks, and (2) individual customer preferential requirements, involving (a) the total number of Server Farm application users and (b) a desirable redundancy level.

This estimation method for availability uses  
30 the following definition of Server Farm availability. This definition is the probability that a Server Farm  
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provides access to applications and data for a particular minimum number of users. As soon as the Server Farm can not serve this particular minimum number of users, it is considered failed. When some of the users have lost  
5 connections but can reconnect to other servers and continue to work, and the majority of users do not experience any interruptions in their work, the farm is not considered failed, if it can still serve this particular number of users.

A widely used approach to improve a system's availability beyond the availability of a single system is by using Server Farms with redundant servers. In this case, if one of the farm's servers fails, the "unlucky" users connected to this server will lose their  
15 connections, but will have an opportunity to reconnect to other servers in the farm and get access to their applications and data. If all of the "unlucky" users get access to their applications and data, the farm is considered "available." If at least one of the "unlucky"  
20 users fails to get access to his/her applications and data, it means that the Server Farm's redundancy was exhausted and the Server Farm is considered failed.

The parameters for MTTF and MTTR can be estimated as indicated in the cited prior USSN 08/550,603  
25 as a single computer virtual time between failures and a single computer virtual downtime period, respectively, for a particular application and user environment.

Therefore, the availability estimation method of the prior application USSN 09/443,926 allows one to  
30 estimate such parameters of the Server Farm as number of servers, Server Farm availability, and Server Farm

downtime, based on a set of input data. At the same time, however, this method did not provide any recommendations about optimum combinations of the Server Farm parameters that can be chosen at the Server Farm planning or design stage.

The method of the co-pending application USSN 09/474,706, entitled "Method for Server Farm Configuration Optimization" involving the Server Farm size optimization is based on the input data that includes single server parameters similar to the prior application USSN 09/443,926 and at least two new extra parameters which include: single server cost and the downtime cost. Additionally, this method included newly added steps of selecting an optimization parameter, selecting an optimization criterion, and using an optimization technique procedure to find the optimum value of the optimization parameter. Therefore the optimization method of the co-pending application USSN 09/474,706 allows one to find the optimum configuration of the single Server Farm. At the same time, however, this method had some technical limitations. The original assumption, that the reliability of the workload balancing mechanism is much higher than the reliability of a single server running applications becomes questionable if the Server Farm size exceeds 100-120 servers. This peculiar problem arises in the situation where a very large number of users  $L$ , say 10,000, 50,000 or 100,000 users are involved.

The presently described new method improves Server Farm availability by using so called Metafarms divided into several Server Farms with a workload

balancing mechanism that distributes workload as between the Server Farms and as between the servers that make up the Server Farms. The Metafarm availability definition is similar to the Server Farm availability definition. The 5 Metafarm availability is the probability that a Metafarm provides access to applications and data for a particular minimum number of users. Therefore this is the probability that all Metafarm Server Farms are available.

The Metafarm design unlike Server Farm design 10 may involve a new parameter - the number of Server Farms of equal size that make up a Server Metafarm. The number of Server Farms can be used as one of the Server Metafarm optimization parameters.

While the present invention may be shown in a 15 preferential embodiment for a Metafarm that uses any workload balancing mechanism, it is not limited thereto, and can be used for any other data processing environment where the definition of the "Metafarm and Server Farm availability" can be applied.

Thus the object of the present invention is to 20 provide a method for optimizing the Server Metafarm for delivery of service to this large number of users by balancing a number of Server Farms and their availability requirements. The method uses the fact that the 25 decomposition of the Metafarm into several Server Farms can increase the Server Metafarm availability. The method will generate an optimum recommendation for the selected set of input data. For example, the input data can include parameters of the particular server that is used 30 as a Metafarm building block and Server Metafarm availability can be selected as optimization criterion.

In this case, the optimum Server Metafarm configuration can include the values of the number of Server Farms of equal size that make up a Server Metafarm and the number of servers in each Server Farm.

5           The method of generating such optimum configurations for this type of network involving large number of users "L" is described and developed in the succeeding exposition hereinbelow.

SUMMARY OF THE INVENTION:

In accordance with the present invention, a novel estimator program performs method steps for the Server Metafarm optimization for a given particular large number of Metafarm users/clients "L" by balancing a number of separate Server Farms and their availability requirements. By the optimization of the Metafarm is herein meant the process of finding the optimum values of the selected optimization parameters (such as a number of Server Farms and/or a Redundancy Factor value) that deliver the optimum value (for the selected optimization criterion (such as Server Metafarm availability) and a given set of input data.

System performance in a Server Metafarm computing environment involves a particular number of concurrent users with the minimum required application response time and reliable access to their applications and data. Server Metafarm availability is the probability that a Server Metafarm provides a required system performance level. A Server Metafarm parameter that indirectly defines the Server Metafarm availability and performance is designated as a Redundancy Factor, that is a measure of the available system resources. The Redundancy Factor involves a difference between the maximum required performance and the nominal performance as a percentage of the maximum performance.

In one particular embodiment, the method uses a simplified Server Metafarm availability model. The model uses Server Metafarm availability as an optimization criterion. The Redundancy Factor and the number of Server

Farms that make up the Metafarm are used as optimization parameters.

The method uses the fact that the decomposition of the Metafarm into several Server Farms can increase 5 the server Metafarm availability.

BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 is a drawing of a data processing system which includes an application Server Metafarm that executes application programs for multiple clients 10 (users). This is an example of the typical system where the optimization method of balancing a number of Metafarm Server Farms and availability requirements can be applied;

Fig. 2 shows an example of the optimization 15 criterion as a function of one of the optimization parameters for a particular value of the second optimization parameter. Here, the optimization criterion is a Metafarm Availability and optimization parameters are a number of Metafarm Server Farms and a Redundancy 20 Factoris;

Fig. 3 shows an example of the optimization criterion as a function of one of the optimization parameters for a particular value of the second optimization parameter. Here, the optimization criterion 25 is a Metafarm MTTF and optimization parameters are a number of Metafarm Server Farms and a Redundancy Factor;

Fig. 4 is a flow chart which shows an estimator program, which performs method steps for estimating the optimum value of two of the possible optimization

parameters of an operating Server Metafarm designed to serve a particular overall number of clients "L".

GLOSSARY LIST OF RELEVANT ITEMS:

1. AVAILABILITY: This is a measure of the readiness of the system and an application to deliver an expected service to the user with a required performance level.

5 It may be described as a percentage of time that a system and an application are running as distinguished from the system being down for maintenance or repairs.

10 2. MEAN TIME TO FAILURE (MTTF): This is the average operating time between two failures, that can be estimated as the total operating time divided by the number of failures.

15 3. MEAN TIME TO REPAIR (MTTR): This is the average "downtime" in case of failure, that can be estimated as the total downtime divided by the number of failures.

20 4. DOWNTIME: The downtime or repair time for a single application server is the time interval required to restore the server and system back to normal business operation. At the end of the repair period the applications running on the repaired server are available to users. The downtime for a Server Farm is the time interval required to restore the nominal Server Farm performance.

25 5. ESTIMATOR PROGRAM: This is a program which performs method steps for estimating system parameters such as the availability of application programs running on any computer, server cluster, or server farm. This type of estimator program was the subject of co-pending

applications USSN 550,603 and USSN 09/443,926, which are incorporated herein by reference.

6. SERVER METAFARM or METAFARM: This designates a group of identical Server Farms (see definition of the Server Farm below) that uses a workload balancing mechanism that distributes requests for services or applications to the available servers.

7. SERVER FARM: This designates a group of identical individual servers wherein each server can provide service to many single individual clients. The Server Farm can run enterprise class client/server applications (SAP, PeopleSoft, Microsoft SQL) or applications that are traditionally run on a single workstation (Microsoft Office 97). The Server Farm usually uses a workload balancing mechanism that distributes requests for services or applications to the available servers.

8. REDUNDANCY FACTOR (Rf): This is a measure of the additional number of users that can be added to the nominal number of users per server without exceeding the maximum number of users per server (server performance benchmark maximum of users). It is a difference between maximum and nominal performance as a percentage of the maximum performance. The Redundancy Factor can be calculated as 100 percent minus a usage factor Uf.

25 9. SERVER FARM AVAILABILITY CALCULATOR: This is an estimator program which estimates the availability for the Server Farm.

10. THIN CLIENT SERVER FARM AVAILABILITY CALCULATOR:

This is one of the examples of the SERVER FARM AVAILABILITY CALCULATORS. Because thin-client configurations are intended to make applications available to multiple users at the same time, this calculator calculates the availability of a specified number of instances of an application (not just a single instance) where each application instance is being run at the server, but all the user input response is taking place at the client terminal. In this scenario, downtime occurs whenever the number of available instances of the application drops below the required specified number of instances.

11. USAGE FACTOR (Uf): This is the ratio of the nominal number of users per server to the maximum number of users per server (server performance benchmark maximum of users) times 100 percent.

12. OPTIMIZATION CRITERION: This is a function that determines the value of one of the essential system attributes and must be minimized (or maximized) by variation of one or more system parameters that are chosen as OPTIMIZATION PARAMETERS. Each optimization parameter should have a predefined domain that defines the values that the optimization parameter may assume. The OPTIMIZATION CRITERION is a focus of an optimum system design or configuration. Examples of the optimization criteria are system performance, system availability, and cost of ownership.

13.  $M_A$  = Metafarm Availability

14.  $M_{MTTF}$  = Metafarm Mean Time to Failure (MTTF)

15.  $K$  = Number of Server Farms in the  
Metafarm.

5 16.  $N$  = Number of Servers in the Server Farm

17.  $P$  = Maximum number of concurrent users  
per server or single server  
application performance benchmark

10 18.  $L$  = Total number of users being serviced  
by the Metafarm,  $L=K*N*P$

DESCRIPTION OF PREFERRED EMBODIMENT:

As seen in Fig. 1, there is illustrated a schematic drawing of a Server Metafarm 8 that consists of a number of Server Farms. These Server Farms will 5 involve a series of Farms designated 10A, 10B, 10C,...,10K.

As a typical example, the Server Farm 10A involves a multiple number of servers designated A1, A2, A3,...,AN. Each of these servers has their own 10 individual application programs respectively shown as 10PA1, 20PA2,...,N0PAN.

Likewise, each of the other Server Farms 10B, 10C, etc., has similar sets of hardware servers. For example, the Server Farm 10K of Fig. 1 has a set of 15 servers designated K1, K2,...,KN, and these servers respectively have their own programs 10PK1, 20PK2,...,K0PKN.

A network 60 connects client terminals designated 1,2,...,L to enable connections to each server 20 in the Server Metafarm. Additionally, each Server Farm has a database unit designated such as 12A for the Server Farm 10A. Likewise, the Server Farm 10K has a database unit designated 12K.

The network bus 60 of Fig. 1 provides 25 connections from the multiple number "L" of client terminals shown as client terminal 1, 2, . . . L.

It should be understood here that this type of situation with the use of a Metafarm involves a large 30 number of client users L, such as 10,000, 50,000, or 100,000 and so on. This is the reason that a Server

Metafarm, such as Server Metafarm 8, requires multiple numbers of Server Farms, such as 10A, 10B, 10C,...,10K.

One of the major problems that arises in optimizing a configuration for a given total number of 5 users L, is to decide how many Server Farms K of equal size N should be used to constitute the entire Server Metafarm, where N = the number of Servers in a Server Farm.

As was illustrated in USSN 09/474,706, the 10 Redundancy Factor is a key parameter in estimating Server Farm availability since it defines Server Farm size. The Redundancy Factor was used as one of the optimization parameters for the optimum Server Farm configuration. The definition of the Redundancy Factor can be applied to 15 Metafarms also. For example, if a Metafarm should serve a large number of users where L=30,000 (Metafarm users) and each of the servers that make up this Metafarm can serve P=100 users, then a Metafarm size K=1 (it is just one farm) and a Server Farm size N (that is a minimum number 20 of servers that can serve L users) is equal to N=30,000/100=300 servers. This Metafarm does not have any redundant servers. According to the Metafarm availability definition, if any of the 300 servers fails, the Metafarm will be considered failed. To improve the Metafarm 25 availability, redundant servers can be added. In case of the Redundancy Factor Rf=10%, the Metafarm resources to serve about 3,000 additional users are considered redundant. In terms of servers, it is about 30 additional servers. (30 is 10% of 300). Unfortunately, the original 30 assumption (made in USSN 09/474,706) that the reliability of the Server Farm workload balancing mechanism is much

higher than the reliability of a single server running applications becomes questionable if the Server Farm size exceeds 100-120 servers. This is why the novel method described here uses the decomposition of the Metafarm 5 into several Server Farms. The Metafarm can be divided into different number of the identical Server Farms with the same number of servers per Server Farm. The redundant servers can then be distributed evenly between Server Farms.

10           The goal of the reliable Metafarm design is to find a configuration with a minimum number of Metafarm servers (optimum configuration) that meets two major requirements:

- 15       1) performance requirement: to serve a given large number of users  $L$ ;
- 2) availability requirement: provide a given Metafarm Availability value  $M_A$  or a given Metafarm MTTF value  $M_{MTTF}$ .

20           Two optimization parameters that define the optimum configuration are the number of Server Farms  $K$  that make up the Metafarm and the Redundancy Factor that defines the overall number of servers.

25           Fig. 2 illustrates an example of the Metafarm optimization. Fig. 2 is a graphical plot of availability against the number "K" of Server Farms for a specified range of Redundancy Factors. The data used for optimization include the following:

- a) performance requirement: provide services for  $L=30,000$  users;

- b) availability requirement: provide Metafarm Availability  $M_A=0.99999$ ;
- c) single server that runs application programs MTTF=1,500 hours;
- 5 d) single server that runs application programs MTTR=6 hours;
- e) single server that runs application programs performance benchmark P=100 concurrent users;
- f) Redundancy Factor domain is an interval (10%, 14%);
- 10 g) Number of Server Farms is a natural number 1, 2, . . . 10.

There are three configurations on Fig. 2 with availability  $M_A$  that is greater or equal 0.99999. Two configurations are for a Redundancy Factor that is equal to  $Rf=14\%$  (where the First configuration includes 345 servers that are distributed between 3 server farms. Each server farm contains 115 servers where 14 servers are considered redundant servers. The second configuration includes 344 servers that are distributed between 4 server farms. Each server farm contains 86 servers where 10 servers are considered redundant servers). The third configuration is for a Redundancy Factor that is equal to  $Rf=13\%$ . (This third configuration includes 342 servers that are distributed between 3 server farms. Each server farm contains 114 servers where 13 servers are considered redundant servers). It is obvious, that the configuration with the smaller value of the Redundancy Factor  $Rf=13\%$  and three Server Farms is the optimum configuration for

this example, because it requires less servers than the two other configurations.

Fig. 3 illustrates the same example of the Metafarm optimization where the availability requirement is given in the form of the Metafarm MTTF value where  $M_{MTTF}$  is equal to 600,000 hours. Again, there are three configurations on Fig. 3 with Metafarm MTTF that is greater than or equal to 600,000 hours. Two configurations are for a Redundancy Factor  $R_f$  that is equal to 14% and one configuration is for a Redundancy Factor  $R_f$  that is equal to 13%. The value of the Metafarm MTTF for 3 Server Farms and Redundancy Factor  $R_f=14\%$  is equal to 1,843,768 hours and is not shown in Fig. 3 due to limited graph size. The optimum configuration is the same as for the availability requirement in the form of the Metafarm Availability value that is equal to 0.99999: so that 3 Server Farms with the Redundancy Factor  $R_f$  of 13% is seen to have the least number of servers that deliver MTTF that is greater than the required goal (600,000 hours).

Now, in accordance with the present invention, steps are provided for optimization of a Server Metafarm designed to serve a particular large number of users "L". These steps will be described in conjunction with Fig. 4 that shows an estimator program, which performs method steps for estimating parameters of the optimum operating Server Metafarm.

In step A of Fig. 4, requests for the following input parameters are displayed: (1) performance requirement in the form of required large number of users "L" for utilizing said Server Metafarm, (2) the maximum

single-server workload "P" of concurrent users (the performance benchmark), (3) the Mean Time To Repair for a single server, and (4) Mean Time To Failure for a single server.

5 In step B of Fig. 4, the values of the requested input parameters are entered on the computer monitor by means of the keyboard.

In step C of Fig. 4, an optimization parameter (parameters) and its (their) domain is (are) selected.  
10 For example, in Fig. 2 and 3, the selected optimization parameters are the Number of Server farms K and the Redundancy Factor Rf. The Number of Server Farms is a natural number 1, 2, . . . 10. The Redundancy Factor domain is an interval (10%,14%) that is the interval  
15 between 0 and 100 percent.

In step D of Fig. 4, an optimization criterion is selected. In Fig. 2, for example, the selected optimization criterion is the Redundancy Factor that should be minimized and, additionally, the selected constraint in the form of the minimum required Server Metafarm Availability value is the Metafarm Availability goal  $M_A$  that should be greater or equal to 0.99999. In Fig. 3, for another example, the selected optimization criterion is the Redundancy Factor that should be minimized and, additionally, the selected constraint in the form of the minimum required Server Metafarm MTTF value is the Metafarm MTTF goal  $M_{MTTF}$  that should be greater than or equal to 600,000 hours.

In step E of Fig. 4, optimization of the optimization criterion selected at step D occurs by one of the known optimization techniques described in the

books: *Practical Optimization* by Philip Gill, Academic Press, 1981 and/or *Engineering Optimization: Methods and Applications* by G. V. Reklaitis and others, John Wiley & Sons, 1983. Fig. 2 and 3 illustrate one of the simplest 5 optimization techniques by the plotting of the graph for a set of values of the optimization parameters. Particularly, the used values of the Number of Server Farms K that make up the Metafarm are natural numbers 1, 2, . . . 10 and the used values of the Redundancy Factor 10 are from 10% to 14% percent with steps of 1%: as for example, 10, 11, . . . 14%. If the accuracy of the calculation is not sufficient, then the value of a step can be reduced from 1% to 0.5%, etc.

In step F of Fig. 4, the optimum values of the 15 optimization parameters are displayed. For example, in Fig. 2 and 3, the optimum value of the Number of Server Farms K that make up the Metafarm is 3 Server Farms and the optimum value of the Redundancy Factor is 13% which corresponds to the Metafarm with 342 servers.

20 Described herein has been an optimization method and an estimator program for a Server Metafarm designed to serve a particular large number of clients L.

While a preferred implementation of the 25 invention has been described, it should be understood that other implementations may be used which are still encompassed by the attached claims.

WHAT IS CLAIMED IS:

1. An estimator program that performs method steps for estimating parameters of the optimum operating Server Metafarm designed to serve a particular large number of clients L comprising the steps of:

5 (a) inputting a group of parameters involving at least one Server Metafarm parameter and at least one single server parameter;

10 (b) selecting at least one Server Metafarm optimization parameter and its domain which indicates the values that the Server Farm optimization parameter may assume;

(c) selecting a Server Metafarm optimization criterion that is a function of said Server Metafarm optimization parameter or parameters;

15 (d) using an optimization technique to find the optimum value (values) of the optimization parameter (parameters).

2. The method of claim 1 wherein said step (a) of inputting said group of parameters includes the steps of:

(a1) selecting for input said particular number of clients "L" for utilizing said Server Metafarm;

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(a2) selecting for input a maximum single server workload of users "P";

(a3) selecting for input a mean time to repair value (MTTR) for a single server;

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(a4) selecting for input a mean time to failure (MTTF) for a single server.

3. The method of claim 1 wherein step (b) for selecting optimization parameters includes:

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(b1) selecting a number of Server Farms that make up a Server Metafarm which is any natural integer number of servers wherein each Server Farm is the same size, in number of servers, as each other Server Farm.

4. The method of claim 1 wherein step (b) for selecting optimization parameters includes:

5

(b2) selecting a Redundancy Factor having a domain which is an interval between 0 and 100 percent.

5. The method of claim 1 wherein step (b) for selecting optimization parameters includes:

5 (b3) selecting a number of Server Farms of equal size that make up a Server Metafarm which number is any natural integer number of servers, and,

(b4) selecting a Redundancy Factor having a domain which is an interval between 0 and 100 percent.

6. The method of claim 1 wherein step (c) for selecting said optimization criteria includes:

5 (c1) selecting an optimization function which is the Server Metafarm Mean Time To Failure.

7. The method of claim 1 wherein step (c) for selecting said optimization criteria includes:

(c2) selecting an optimization function which is the Server Metafarm Availability.

8. The method of claim 1 wherein step (c) for selecting said optimization criteria includes:

5 (c3) selecting an optimization function which is the Redundancy Factor that should be minimized and, additionally, selecting a constraint in the form of the minimum required Server Metafarm Mean Time To Failure value.

9. The method of claim 1 wherein step (c) for selecting said optimization criteria includes:

5

(c4) selecting an optimization function which is the Redundancy Factor that should be minimized and, additionally, selecting a constraint in the form of the minimum required Server Metafarm Availability value.

10. The method of claim 1 wherein step (d) for using said optimization procedure includes the steps of:

5

(d1) selecting a value of said optimization parameters from said domain;

(d2) calculating a value for said optimization criterion;

(d3) making an evaluation decision about the end or the continuation of said optimization procedure.

11. The method of claim 10 wherein step (d3) involves the decision to stop the procedure if the optimum number of Server Farms in the configured Server Metafarm is determined.

12. The method of claim 10 wherein step (d3) includes the step of:

5

(d3a) continuing the optimization procedure if the optimum number for each single Server Farm size is not yet determined, by repeating said step (d2) with another value of said optimization parameter (parameters) from said domain (domains).

**ABSTRACT OF THE DISCLOSURE:**

## **TITLE: METHOD FOR SERVER METAFARM CONFIGURATION OPTIMIZATION**

A method and a novel estimator program are provided for Server Metafarm optimization for a given particular large number of the Metafarm users/clients "L" by balancing a number of separate Server Farms and their availability requirements. By the optimization of the Metafarm is herein meant the process of finding the optimum values of the selected optimization parameters (such as a number of Server Farms and/or a Redundancy Factor value) that deliver the optimum value for the selected optimization criterion (such as Server Metafarm availability) and a given set of input data.

**FIG. 1**

SERVER METAFARM 8

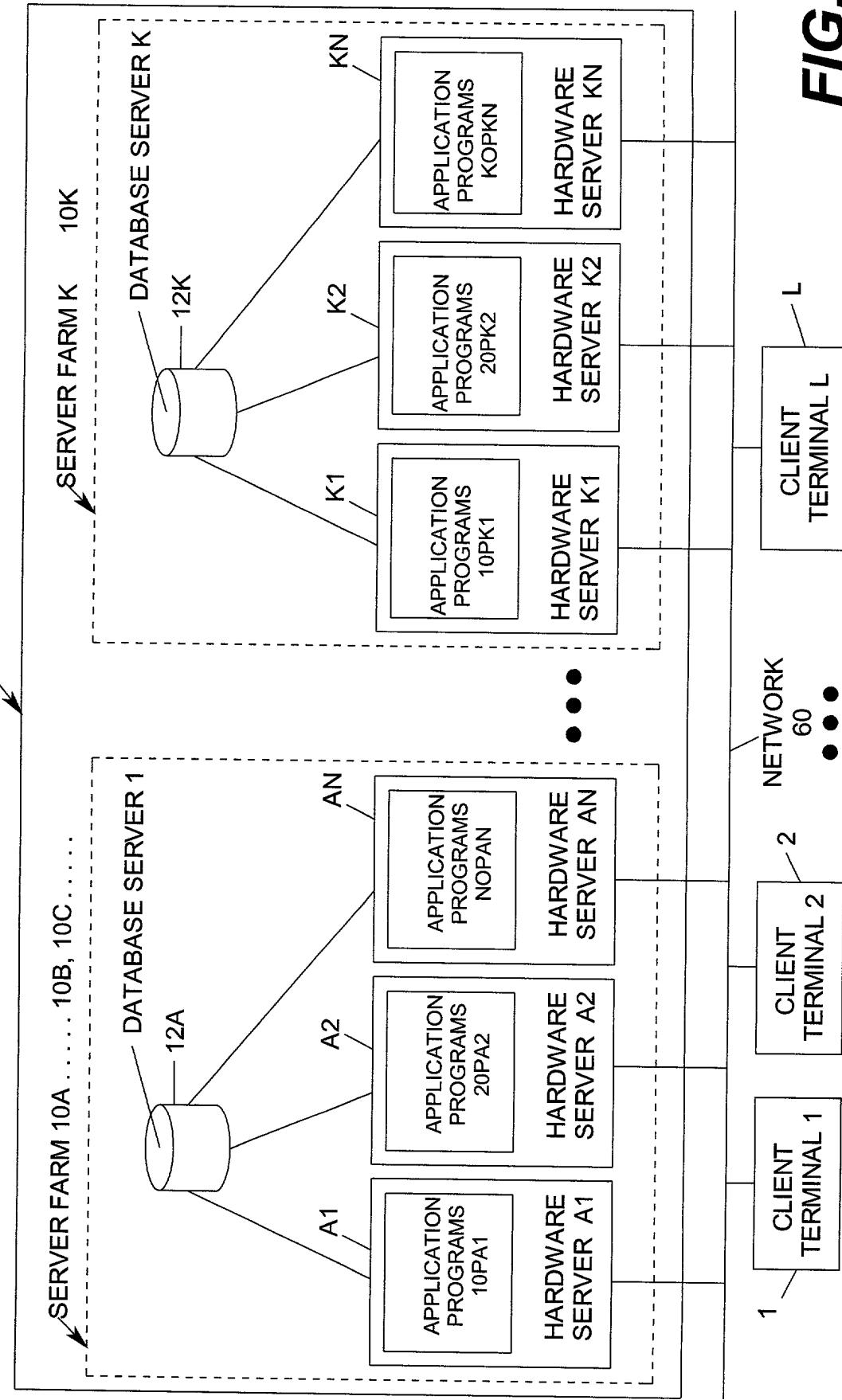


Fig. 2

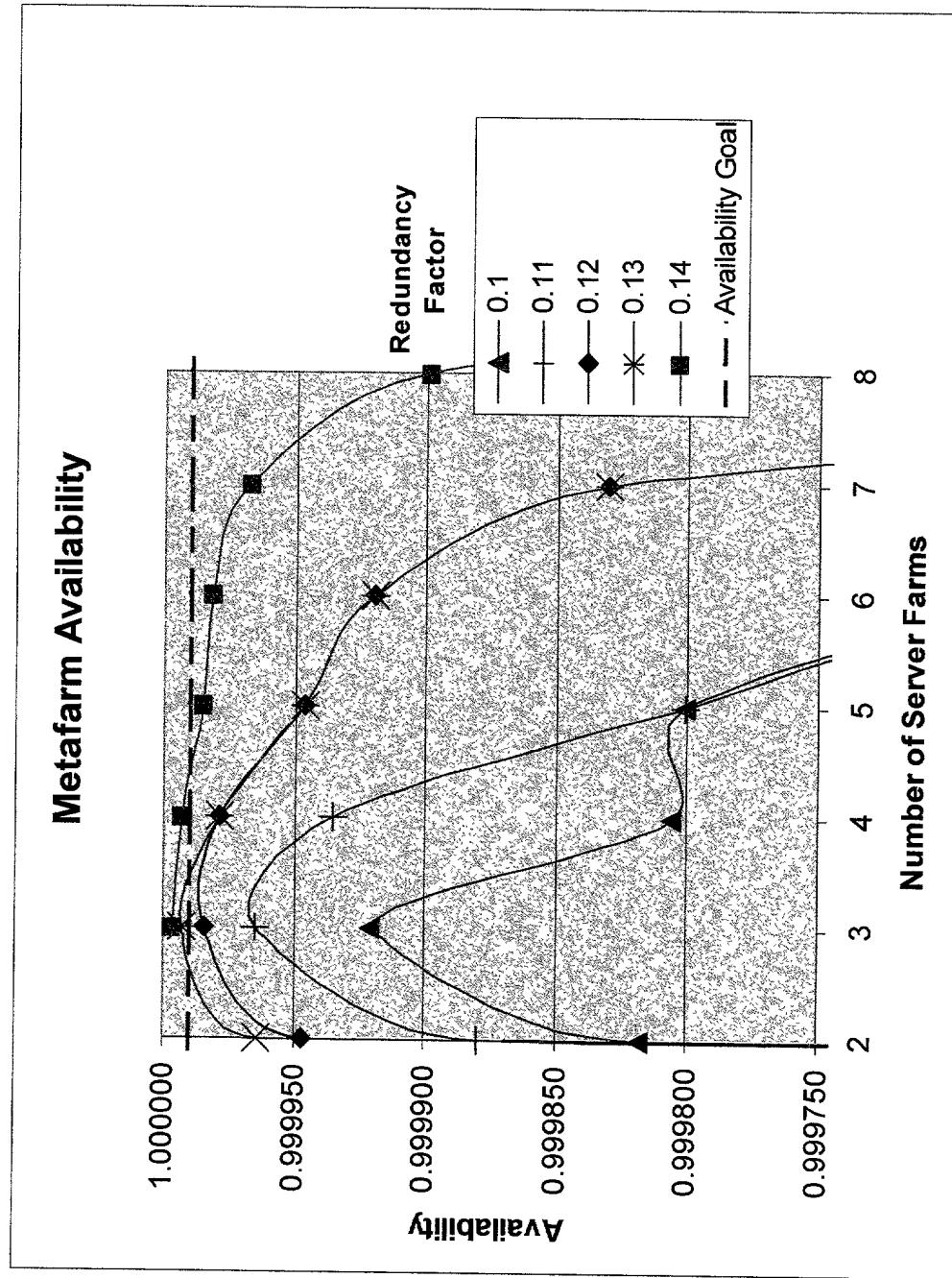
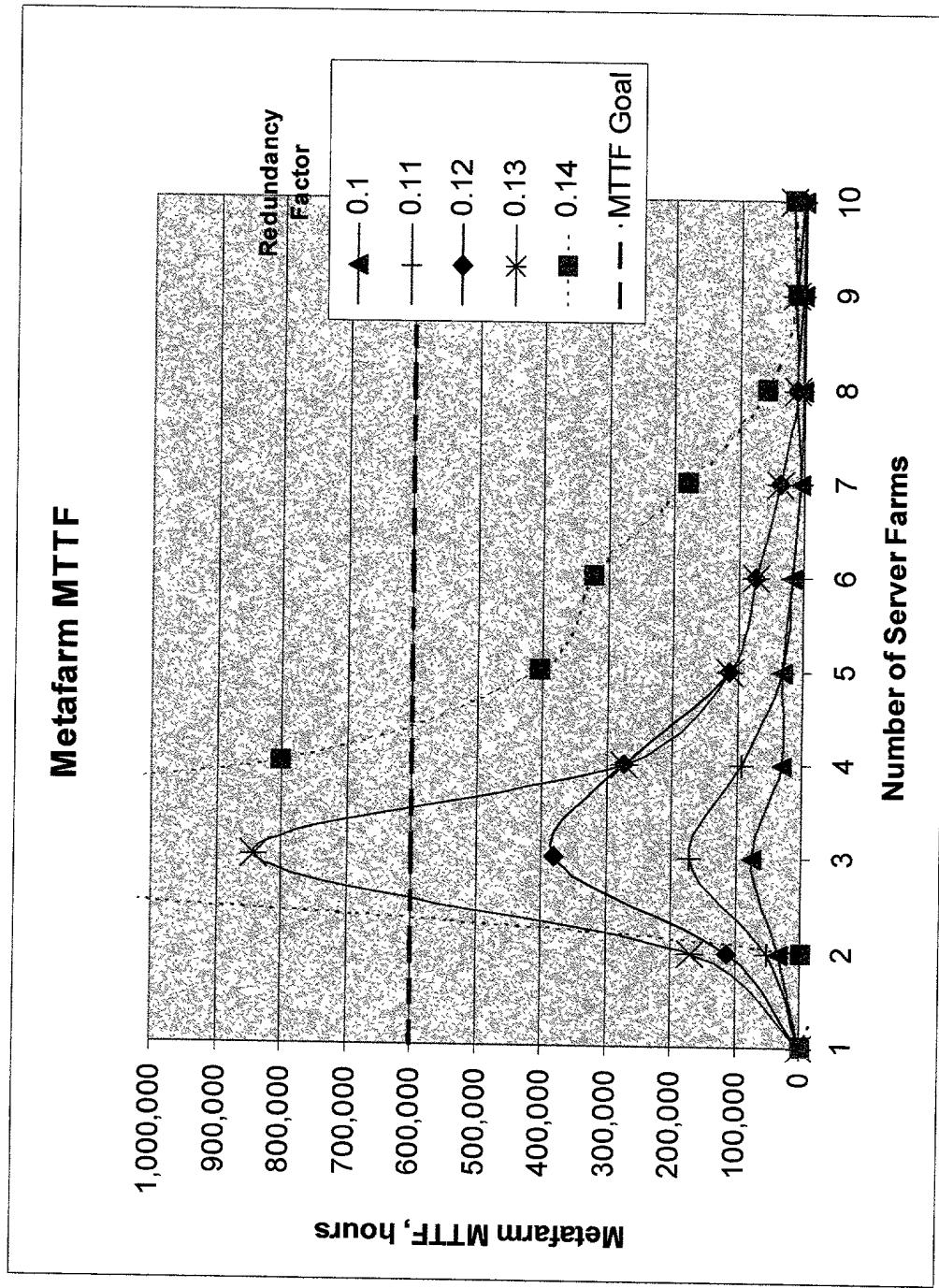
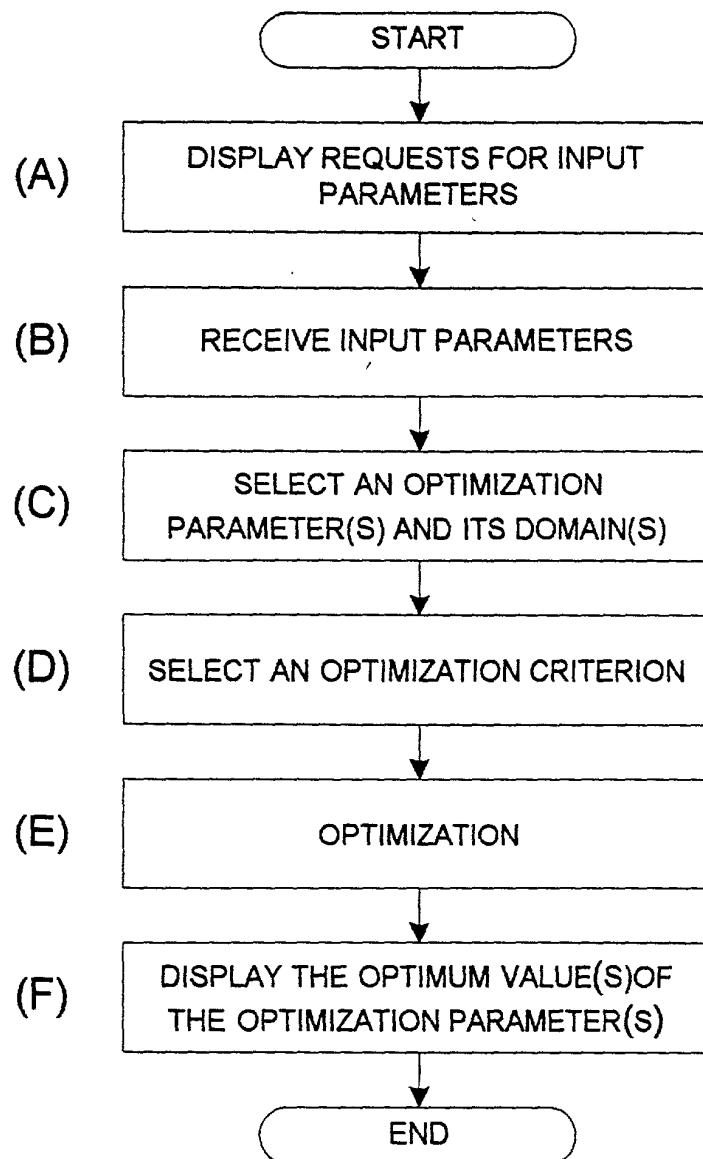


Fig. 3





F i g . 4

**PATENT**

Attorney's Docket No. 041-479-L

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**COMBINED DECLARATION AND POWER OF ATTORNEY**

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As a below named inventor, I hereby declare that:

**TYPE OF DECLARATION**

This declaration is of the following type:

- X original
- design
- supplemental
- divisional
- continuation
- continuation-in-part (CIP)

**INVENTORSHIP IDENTIFICATION**

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**TITLE OF INVENTION**

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**METHOD FOR SERVER METAFARM CONFIGURATION OPTIMIZATION**

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**SPECIFICATION IDENTIFICATION**

the specification of which: (complete (a), (b) or (c))

- (a) X is attached hereto.
- (b) \_ was filed on \_\_\_\_\_ as  Serial No.  
or  Express Mail No., as Serial No. not yet known

**ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR**

I hereby state that I reviewed and understand the contents of the above identified specification, including the claims, as amended by an amendment referred to above.

I acknowledge the duty to disclose information

- which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56
- and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable examiner would consider it important in deciding whether to allow the application to issue as a patent, and

— In compliance with this duty there is attached an information disclosure statement in accordance with 37 CFR 1.98.

#### **POWER OF ATTORNEY**

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

ALFRED W. KOZAK, REG. NO. 24,265  
MARK T. STARR, REG. NO. 28,762

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SEND CORRESPONDENCE TO

ALFRED W. KOZAK  
UNISYS CORPORATION  
10850 VIA FRONTERA, MS 1000  
SAN DIEGO, CALIFORNIA 92127

DIRECT TELEPHONE CALLS TO:  
(Name and telephone number)

ALFRED W. KOZAK  
(858) 451-4615

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#### **DECLARATION**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

**SIGNATURE(S)**

Full name of sole or first inventor:

Lev  
(GIVEN NAME)

(N.M.I.)  
(MIDDLE INITIAL OR NAME)

Smorodinsky  
FAMILY (OR LAST NAME)

Inventor's signature

Date 11/01/2000 Country of Citizenship USA

Residence: 25121 Grissom Road, Laguna Hills, California 92653

Post Office Address same as above